REMARKS

All of the claims submitted for examination in this application have been rejected on four substantative grounds. Applicants have reviewed these grounds of rejection and respectfully submit that all of the claims currently in the application are patentable thereover.

The first substantive ground of rejection is directed to Claims 1-13. Claims 1-13 stand rejected, under 35 U.S.C. §103(a), as being unpatentable over U.S. Patent Application Publication No. US 2002/0052125 A1 to Shaffer, II et al. taken in view of U.S. Patent No. 6,121,130 to Chua et al. and in further view of U.S. Patent No. 5,908,510 to McCullough et al.

The principal Shaffer, II et al. application discloses a process for forming an etched, coated semiconductor device followed by removing impurities comprising disposing a low dielectric constant curable organic polymeric film, generally as a multi-layer film on an electrically-conductive surface of a semiconductor substrate device, curing the film layers and contacting the film layer with heat, in a baking step, to remove impurities from the film and the device.

The Official Action admits that the claims of the present application differ from the Shaffer, II et al. disclosure by the requirement that the cured polymeric organic film be contacted with supercritical carbon dioxide. In view of this failing, the Official Action applies Chua et al. for its teaching of removing both residual solvent and polymerization by-products from a semiconductor substrate coated with a film by thermal steps and McCullough et al. for its disclosure of removing residue from semiconductor devices that may include both etched and patterned composites having both silicon and polymeric layers by contact with supercritical carbon dioxide, the contact generally being at a significantly elevated temperature.

Based on these disclosures, the Official Action concludes that it would have been obvious to one skilled in the art to have enhanced the Shaffer, II et al. process by contacting the cured and coated semiconductor device with supercritical carbon dioxide to more thoroughly and completely remove a variety of residual impurities from the device.

It is emphasized at the outset that the present invention represents a significant advance in the art by providing a method of removing impurities from a low dielectric constant organic polymeric film disposed on a semiconductor device. Up to the time of the present disclosure, removal of impurities and foreign materials from organic polymeric low dielectric films employed in semiconductor devices involved contact of the cured low dielectric films with deionized water or exposure of the semiconductor device to elevated temperatures. Attention is directed to the specification, at Page 2, lines 12-21, wherein this disclosure is set forth.

It is indeed surprising that the Shaffer, II et al. disclosure does nothing more than illustrate one of these two prior art methods of removing impurities of foreign materials from cured low dielectric films. As stated in the Official Action, Shaffer, II et al. discloses a baking step to remove impurities from the film and the device. This method, as indicated in the specification of the present application, represents nothing more than the known prior art.

To supplement the inadequacy of the principal Shaffer, II et al. reference, the Official Action applies, as a secondary reference, Chua et al. for its reference of removing residual solvent and polymerization by-products from a semiconductor substrate coated with a film by thermal steps. As such, Chua et al. does not supplement the teaching of Shaffer, II et al. Indeed, the Official Action implicitly admits that Chua et al. adds nothing to the Shaffer, II et al. reference by its admission that Shaffer, II et al. requires further supplementation. Since Chua et al. is substantially redundant with the Shaffer, II et al. disclosure, it is apparent that the

combination of these references does not disclose or suggest the invention embodied in Claims 1-13. Each of Claims 1-13 requires that supercritical carbon dioxide contact the organic polymeric film.

In view of these facts, it is apparent that the teaching of the McCullough et al. reference is determinative. McCullough et al. describes a method of removing residue by contact with supercritical carbon dioxide. However, McCullough et al. does not disclose or suggest contact of supercritical carbon dioxide with a <u>cured organic polymeric film</u> as required by each of Claims 1-13. (Emphasis added). The process disclosed in McCullough et al. removes residue from an etched precision surface, such as a semiconductor, by exposing a precision surface containing residue to supercritical carbon dioxide to remove that residue from the precision surface. This disclosure is far removed from contact with a curable organic polymeric film, as required by all of the claims of the present application. As set forth in the specification, at Page 2, line 22 to Page 3, line 3, applicants submit that although the use of supercritical carbon dioxide in the processing of semiconductor devices is known in the art, for example, the removal of reactive ion etching (RIE) impurities of foreign materials, removal of foreign components from cured organic polymeric dielectric insulating films by contact with supercritical carbon dioxide is unknown. Indeed, the above-identified specification paragraph mentions the applied McCullough et al. disclosure. However, as indicated in the specification, McCullough et al. merely addresses the removal of halogenated etched residue from a RIE precision surface by contact with supercritical carbon dioxide. That teaching is far removed from contacting a low dielectric constant cured film surface with supercritical carbon dioxide to remove impurities therefrom.

The mere removal of debris from vias, openings and the like, provided on precision surfaces, such as a semiconductor device, is far removed from the removal of foreign substances from a cured polymeric film. Indeed, the two processes share no similarities. In one case, debris is removed from openings that cannot be penetrated by traditional fluids. Although that in and of itself is clearly surprising when first disclosed, it bears no relation to the removal of foreign substances from a cured polymeric film. The only similarity between the two concepts is that the cured polymeric film is disposed on a precision surface. However, where the cured organic polymeric film is disposed is irrelevant to the concept that is embodied in the claims of the present application. In view of the clearly distinguished nature of the claimed process of the present application compared to that of McCullough et al. and in view of the prior art nature of the other two applied references, it is apparent that none of Claims 1-13 are made obvious by the combined teaching of Shaffer, II et al., Chua et al. and McCullough et al.

It is furthermore emphasized that although the McCullough et al. disclosure of removing RIE residue from precision surfaces with supercritical carbon dioxide includes patterned film structures and the patterned film structures and that the patterned film structure may be a polyimide, that disclosure is far removed from the totally distinguished process of removing impurities from a cured low dielectric constant organic polymeric film. Such impurities removal is independent of whether the semiconductor device is subjected to reaction ion etching, a separate and distinct processing step in the manufacture of precision surfaces.

The second substantive ground of rejection is the rejection of Claims 1 to 13, under 37 C.F.R.§103(a), as being unpatentable over McCullough et al. in view of Shaffer, II, et al.

The Official Action avers that McCullough et al. teaches the forming of a semiconductor substrate or wafer, disposing a low constant curable polymeric film, such as a polyimide or other

polymer, on an electrically conductive surface and then cleaning the film surface by contacting the surface with supercritical carbon dioxide to remove residue and impurities.

The Official Action analysis admits only to McCullough et al. not disclosing the requirement that the film is cured. Thus, the Official Action applies Shaffer et al. for its teaching of curing a polymeric film on a semiconductor substrate. As such, the Official Action concludes that it would have been obvious to one skilled in the art to have augmented the McCullough et al. method by curing the polymeric material, taught by Shaffer, II et al., in order to permanently adhere the film to the substrate and prepare the device for etching.

It is axiomatic that a reference must be analyzed for its complete teaching rather than taking snippets from that reference that can be ingeniously pieced together to come up, in hindsight, with a claimed invention. What has been done in this case is the use of the present application as a template from which statements were taken out of context from the McCullough et al. reference to come up with a colorable teaching of the claimed invention of the present application.

In fact, McCullough et al. is directed to a method of removing residue material from a precision surface which has been subjected to an etching process (Col.1, lines 5-8) not a method for the formation of semiconductor substrate. There is no requirement in the claimed process of the present application that the electrically conductive surface of the semiconductor device undergo an etching process. Therefore, the McCullough et al. teaching is totally irrelevant to the claims of the present application.

It is conceded that Shaffer, II et al. is relevant to the process of the present application. However, that disclosure is totally free of any teaching of removing impurities produced during the procedure of disposing a low dielectric constant curable organic polymeric film on an

electrically conductive surface of a semiconductor device and curing that organic film as, for that matter, is McCullough et al.

In summary, the two applied references are not combinable, directed as they are to totally dissimilar inventions. One is directed to the removal of etching residue from precision surfaces. The other is directed to the disposition and curing of an organic polymer on a substrate. The only motivation for their combination is the motivation provided by the disclosure of the present application. Clearly then, the combined teaching of McCullough et al. and Shaffer, II et al. does not make obvious, to one skilled in the art, any of Claims 1 to 13.

The third and fourth substantive grounds of rejection are directed to Claims 14 to 17. Claims 14 to 17, in the third ground of rejection, stand rejected, under 35 U.S.C.§103(a), as being unpatentable over Shaffer, II et al. in view of Chua et al. taken in further view of McCullough et al. and in further view of U.S. Patent 6,558,475 to Jur et al.

Alternatively, in the fourth ground of rejection, Claims 14 to 17 stand rejected under 35 U.S.C.§103(a), as being unpatentable over McCullough et al. in view of Shaffer, II et al. taken in further view of Jur et al.

In both third and fourth grounds of rejection the basis of rejection of the applied references is as they are applied to Claims 1 to 13 in further view of Jur et al. The Official Action, admitting that Claims 14 to 17 are patentable over the first and second grounds of rejection, states that Claims 14 to 17 require the contacting of supercritical carbon dioxide be accompanied with at least one co-solvent. Thus, each of those grounds of rejection include the application of Jur et al. which, the Official Action argues, teaches a method aimed at improving the method of the applied McCullough et al. reference by adding a solvent to supercritical carbon dioxide.

Applicants emphasize that the predicate for patentability of Claims 1-13, in view of the absence of any disclosure in the applied prior art of a teaching of contacting a cured polymeric organic film with supercritical carbon dioxide, predicates patentability of Claims 14-17 which also requires that contact, albeit in the additional presence of an additional solvent.

That the newly applied reference of this third and fourth grounds of rejection discloses the use of a solvent with supercritical carbon dioxide in processes remote from the process of Claims 14 to 17 does nothing to make obvious the process of these claims. Indeed, that the invention of applying supercritical carbon dioxide alone in a process of removing impurities from a cured low dielectric constant is patentable only emphasizes the more remoteness of Claims 14-17 from the teachings of the prior art.

The above remarks establish the patentability of the claims of the present application over the four substantative grounds of rejection imposed in the outstanding Official Action. Reconsideration and removal of these grounds of rejection in view of these remarks is therefore deemed appropriate. Such action is respectfully urged.

The above remarks are all advanced on the theory that the substantive grounds of rejection do not present a prima facie case of obviousness. The outstanding Official Action provides elaborate arguments in support of the proposition that the grounds of rejection present prima facie grounds of rejection.

It strongly urged that even if the outstanding Official Action is correct in asserting that each of the grounds of rejection present a prima facie case of obviousness, which applicants strenuously deny, the showing of unexpected results rebuts any presumption of obviousness.

Attention is directed to the Figure and the discussion thereof of Example 1 and Comparative Example 1, at Page 14 of the specification. As stated therein, a cured organic

polymeric film, e.g., polyarylene resin, untreated with supercritical carbon dioxide has a higher mean refractive index than the same cured organic polymeric film treated with supercritical carbon dioxide. As those skilled in the art are aware, the higher the mean refractive index, the greater the amount of foreign material in the cured organic film. This unexpected result is not so much as hinted at any of the references applied in the substantive grounds of rejection.

Yet further evidence of the unexpected result obtained by the treatment of a cured organic polymeric film with supercritical carbon dioxide is provided by the comparative data provided by Example 2 and Comparative Examples 2 and 3. In these examples the polymeric films were analyzed utilizing thermal desorption mass spectrometry (TDMS).

The film produced in Example 2, in accordance with the process of the present application, wherein the cured polyarylene film was contacted with supercritical carbon dioxide, was distinguished from the films of Comparative Examples 2 and 3, wherein no treatment or final treatment with supercritical carbon dioxide occurred, insofar as the masses at 77, 91 and 117 establish the presence of volatile aromatics, in the films formed in Comparative Examples 2 and 3. Thus, this showing provides additional evidence that treatment with supercritical carbon dioxide removes undesirable impurities in the form of aromatic byproducts formed during curing.

As such, neither the combined teaching of the applied Shaffer, II et al., Chua et al. and McCullough et al. references nor the combined teaching of McCullough et al. and Shaffer, II et al. in respect to Claims 1-13, and the combined teaching of Shaffer, II et al., Chua et al., McCullough and U.S. Patent 6,558,475 to Jur et al., in respect to Claims 14-17, make obvious any of the claims of the present application. As stated above, even if the combination of the

applied references presented a prima facie case of obviousness, this second showing rebuts that presumption.

To emphasize the patentability of the claims of the present application, applicants have amended Claim 1 to limit the identity of the low dielectric constant curable organic polymeric film to a polyarylene resin. In this way, the showing is commensurate with the scope of the claims.

With the amendment to Claim 1, Claim 2 becomes redundant and has been cancelled. In addition, with the cancellation of Claim 2, the dependency of Claim 3 has been amended to depend from Claim 1.

In addition, dependent Claim 8 has been redrafted in independent form as new Claim 18. However, its scope remains unchanged. Claims 9 and 10 have been amended to recognize the introduction of Claim 18. With the introduction of Claim 18, Claim 8 has been cancelled.

Those skilled in the art are aware that the showing discussed above with regard to polyarylene resin films applies equally to polysilsesquioxane film.

The amendment to Claim 1 necessitated the further amendment of Claims 13 and 14 wherein the low dielectric constant organic film is limited to a polyarylene film.

The above amendments to the claims presents no new issues nor requires any additional consideration and/or search. As suggested above, these amendments limit the claims to those already in the application. Thus, all the claims currently in this application were of record in this application before final rejection. Introduction of the present amendment is therefore deemed appropriate. Such action is respectfully urged.

The above amendment and remarks establish the patentable nature of all the claims currently in this application. Notice of Allowance and passage to issue of these claims, Claims 1, 3-7 and 9-18, is therefore respectfully solicited.

Respectfully submitted,

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